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No. in Bradley (1755).	Star's Name.	Proper Motion in R.A.	Proper Motion in N.P.D.
		s	"
3195	Bradley 3195	—	+0·02
3200	31 Piscium c^1	−0·001	+0·01
3201	32 Piscium c^2	−0·005	+0·03
3212	Bradley 3212	—	+0·18

ι Aurigæ. The R.A. of the Fundamenta is 1′ too large.
Bradley 1458. The places given in the Fundamenta are in error.

On the Periodic Time of α Centauri. By E. B. Powell, M.A.

For the last four or five years I have been led to believe that the period of *α Centauri* has been considerably underestimated by calculators of orbits for that binary, myself included; and I now beg to lay before the Society the grounds on which I have come to this conclusion. Dr. Elkin's orbit and Mr. Downing's modification of the same no doubt accord very closely with observations between 1834 and 1877, and I imagine only comparatively slight changes will be found requisite in regard to all the elements save the period. The comes has been watched pretty closely through a change of position angle of more than 330°, corresponding to a change of true anomaly of more than 250°. The question now is, how far the apparent or perspective orbit runs out in the south-preceding direction. In connection with this point I propose to refer to some early notices of the star.

I believe the earliest observation of *α Centauri* is one by Father Richaud, recorded in observations, mathematical and physical, sent by certain Jesuit Fathers to the Royal Academy of Sciences at Paris, and published in 1692. In this work occurs isolated Richaud's note, which is as follows:—

" Regardant à l'occasion de la comète plusieurs fois les pieds du *Centaure* avec une lunette d'environ douze pieds, je remarquai que le pied le plus oriental et le plus brillant étoit une double étoile aussi bien que le pied de la croisade; avec cette différence que dans la croisade, une étoile paroît avec la lunette notablement éloignée de l'autre; au lieu qu'au pied du *Centaure*, les deux étoiles paroissent même avec la lunette presque se toucher; quoique cependant on les distingue aisément."

Richaud observed the comet referred to at Pondicherry in December 1689; hence the epoch of his observation may be taken approximately as 1690. The components of *α Crucis* spoken of are, I imagine, not the two close stars, but those two seen as one and the third—a sixth magnitude star. The close stars are about 5″ apart, while the third is about 90″ distant from the close one. The near stars, if moving, are moving very slowly, though the recorded measures of distance in this century,

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supposing they can be relied on, indicate a decrease of that quantity. The use of the word "notablement" supports my view. Now we have Newton's remark in the "System of the World," that in his time the brighter fixed stars appeared through the telescope with a good full light to be 5″ or 6″ in diameter, and that with a fainter light they ran out to a greater breadth. Taking this remark into account it seems probable that the distance of *α Centauri*, as measured in the modern manner from centre to centre of the components, did not in 1690 fall short of 7″, and probably was in excess of that angle. But by forming a table showing the distances, on hypothetical periods ranging through 76, 77, &c., years, as determined by distance measures in the present century, we find that periods of 80, 81, &c., to 86 years are inadmissible in consequence of affording distances below 7″. Thus a period of 80 years would for two revolutions from 1690 bring us to 1850, when the distance was about $6\frac{3}{4}''$; and a period of 81 years in the same way would bring us to 1852, when the distance was $5\frac{1}{2}''$. These considerations seem to bar any period between 80 years and 86 years. It is true, however, that the grounds on which this conclusion is based are not certain ones, and that consequently we cannot do more than attribute a measure of probability to it.

The next notice of *α Centauri* to which I wish to call attention is one carrying much more weight. It is that by Father Louis Feuillée, described as "Religieux Minime, Mathématicien, Botaniste de Sa Majesté, et correspondant de l'Académie Royale des Sciences." The note is in the *Journal of Observations, Physical, Mathematical, and Botanical*, made by order of Louis XIV. between 1707 and 1712. The journal was published in 1714, and the observation was made at Lima on July 4, 1709. The notice is as follows:—

"Sur les deux heures du matin, en attendant que je pusse observer l'émersion du premier satellite de *Jupiter*, que des nuages me cachèrent, j'observai avec une lunette de 18 pieds l'étoile de la première grandeur qui est au pied boréal du devant du *Centaure*; je trouvai cette étoile composée de deux, dont l'une est de la troisième grandeur et l'autre de la quatrième. Celle de la quatrième grandeur est la plus occidentale, et leur distance est égale au diamètre de cette étoile."

There are two points to be noticed in the above extract. First, the comes is declared to have been west of the primary; and secondly, the distance is said to have been equal to the diameter of the comes. We now know that the far larger portion of the orbit of *α Centauri* lies to the west of the meridian through the primary, the eastern portion having been described in the interval between about 1862·7 and 1879·9, or approximately 17 years. It follows, therefore, that if Feuillée's observation be correct, viz. that in 1709·5 the smaller star was west of the larger, the period must either fall short of $\frac{1}{2}$(1862·7 —1709·5), *i.e.* 76·6 years, or must exceed $\frac{1}{2}$ (1879·9—1709·5),

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i.e. 85·2 years, any intermediate value being out of the question. It appears highly improbable that an experienced observer such as Feuillée was could have made the mistake of turning east into west; and unless such a mistake was made, the observation must be regarded as of the highest importance. If, as I now believe, so short a period as 76·6 years will not allow of the requisite extension of the orbit of *α Centauri* in the south-preceding direction, it follows that the period must exceed 85·2 years.

Turning to the second point in Feuillée's notice, viz. the apparent distance of the components, and assuming that the distance he referred to was the interval between the apparent disks of the stars, the distance between the components from centre to centre could not well be less than $3'' + 2\frac{1}{2}'' + 5''$, *i.e.* $10\frac{1}{2}''$. But forming a table similar to that spoken of when discussing Richaud's observation, we find that such a distance is incompatible with any period between 79 or 80 years and 87 years.

Summing up the results for both Richaud and Feuillée, and even allowing for error in estimating the apparent diameters of the stars, I think the observations of those astronomers, taken with the presumed necessity of allowing a greater extension to the orbit in the south-preceding direction than is compatible with a period of 76·6 years, point strongly to the time of revolution not falling short of 86 or 87 years.

Some three years ago I found that a period of over 89 years, with a semi-major axis of above 18″, and other elements but little different from those already arrived at, afforded results, certainly not in good accordance with observation, but still not offensively discordant save in the case of the epoch 1877·6, when θ_0 differed from θ_c by nearly 6°. I do not, however, believe that the period can be so large, and I merely mention the circumstance to show that so great an extension of the time of revolution does not destroy the correspondence of the computed and the observed motions. Last year, after various trials, I arrived at an orbit with a period of 86·56 years, which agreed with observation to within 1° of position angle for all the measures (14 in number) which I put in comparison from 1834 to 1876; from 1876 to 1881 the values of $(\theta_0 - \theta_c)$ were larger but not excessive except in the case of the epoch 1878·38, for which the value was $7^\circ{\cdot}25$, the errors for 1880 and 1881 again falling below 1°. Curiously enough the orbit to which I refer made the value of $(\theta_0 - \theta_c)$ for 1878·185 only $-0^\circ{\cdot}2$, while Mr. Downing considers θ_0 for that date to be very considerably in error. The components were so close to one another in 1877 and the early part of 1878 that errors of some magnitude could scarcely be avoided, especially as the stars are large; and probably it will be advisable to defer making further orbital calculations till three or four years additional measures will, as it were, allow the observations taken in 1877 and 1878, near the lesser minimum distance, to be given only a secondary influence in

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determining the elements. I trust the points I have noticed above, some of which I have touched on in an incidental manner in former papers, will be considered to possess some interest; and I observe that in the remarkable papers lately put forward by Drs. Gill and Elkin upon the parallax of *α Centauri* it is stated that those astronomers saw reason to conclude that the period of *α Centauri* must be longer than the value originally assigned by Dr. Elkin.

In arriving at the orbits formerly submitted by me, I placed great reliance upon Maskelyne's observation at St. Helena in July 1761, according to which the distance was then between 15″ and 16″. The measure was made with a divided object glass micrometer fitted to a reflecting telescope by Short. On hearing, through a common friend, that I was anxious to obtain information regarding this observation, the present Astronomer Royal was kind enough to send me a copy of certain entries in Maskelyne's manuscript note-book referring to measures taken with the above micrometer. From the entries I find that, while Maskelyne made the distance for *α Centauri* to be 15″·6 by two measures, he brought out on the same night the distance of the comes of *β Scorpii* as 7″·2 by one measure. In regard to the latter, he states it was much less exact than the distance measure of *α Centauri*, and he remarks that no observation of distance "of this kind" can be taken very precisely. It may be noticed, in passing, that on the same night the micrometer gave 11″ as the diameter of the disk of *Arcturus*. Now it happens that from the *Philosophical Transactions* of the Royal Society, vol. liv., we learn that in August 1761, while at St. Helena, Maskelyne measured with great care, with a 10-ft. sector, the difference of declination of the two stars of *β Scorpii*, and made it by the mean of six nights to be 13″·97. From this it becomes evident that no reliance can be placed upon the distance measures with the object-glass micrometer, as that apparatus actually made the distance little more than one-half the difference of declination, or in other words, made the hypotenuse of a right-angled triangle only a trifle greater than half one of the sides. In these circumstances it seems clear that we must set aside Maskelyne's distance measure of *α Centauri*, although it was taken with greater care than that of *β Scorpii*, the former being the mean of two observations, and the latter only a single measure; the micrometer was in fact so imperfect in its nature as entirely to vitiate the results. And it is to be recollected that Maskelyne's distance measure was one of the chief supports (in my eyes the chief one) of the short period of seventy-six years or thereabouts.

It must be allowed that La Caille's measures of difference of Declination and difference of Right Ascension do not support so long a period as 86 or 87 years; but his apparatus, however carefully and skilfully used, was certainly not competent to deal at all accurately with seconds of space; therefore the results

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arrived at by this astronomer cannot be permitted to guide us in the present question.

Fallows had also very inadequate instruments to work with, consequently much weight cannot be attached to his measures; but, so far as they go, they suggest a *very* considerably greater elongation in the south-preceding direction than Dr. Elkin's orbit would allow, in fact a greater one than even now seems to be warranted by the circumstances I have dwelt on above. I may mention that the measures of Rümker and Dunlop also indicate that the orbit runs out tolerably far in the south-preceding direction.

On the whole I cannot but think it highly probable that the apparent orbit is considerably larger than has been supposed, and that the period may embrace some 86 or 87 years.

Hampstead:
1884, *Nov.* 12.

Note on Stellar Photography. By A. A. Common.

Photography, as a means of charting the stars in a rapid and most accurate manner, is now, through the introduction of the gelatine dry plate, likely to come into extensive use, if it does not entirely supersede the old method of eye observation of each separate star. Its power to picture the stars in their proper relative positions and magnitudes in a way that is free from personal error, and under conditions that can be easily and certainly reproduced at any future time, renders the work done in this way so valuable in many investigations, that it is hardly possible to properly estimate it, while the much greater amount of work that can be done will render it still more valuable.

As is well known, photographs of double stars and clusters of stars have been made many years ago, but from the difficulties in connection with the use of the wet plate process then generally employed, the results were not very great in comparison with the trouble that was required. A negative of the *Pleiades*, now in possession of this Society, by Rutherfurd, is perhaps one of the best photographs by this old process.

Many other photographs have been taken from time to time in this manner, but it is but recently that the practicability of taking large fields with comparatively small apertures has been shown.

Attention was, I believe, first drawn to this by the remarkable photographs of the great comet of 1882 that were taken at the Cape and sent home by Dr. Gill. Through the kindness of Dr. Huggins I saw one of these photographs very soon after it came to England, and I must say that I was extremely surprised at the number of stars that were shown. It is true that they were large and ill-defined, particularly at the edge of the plate, but